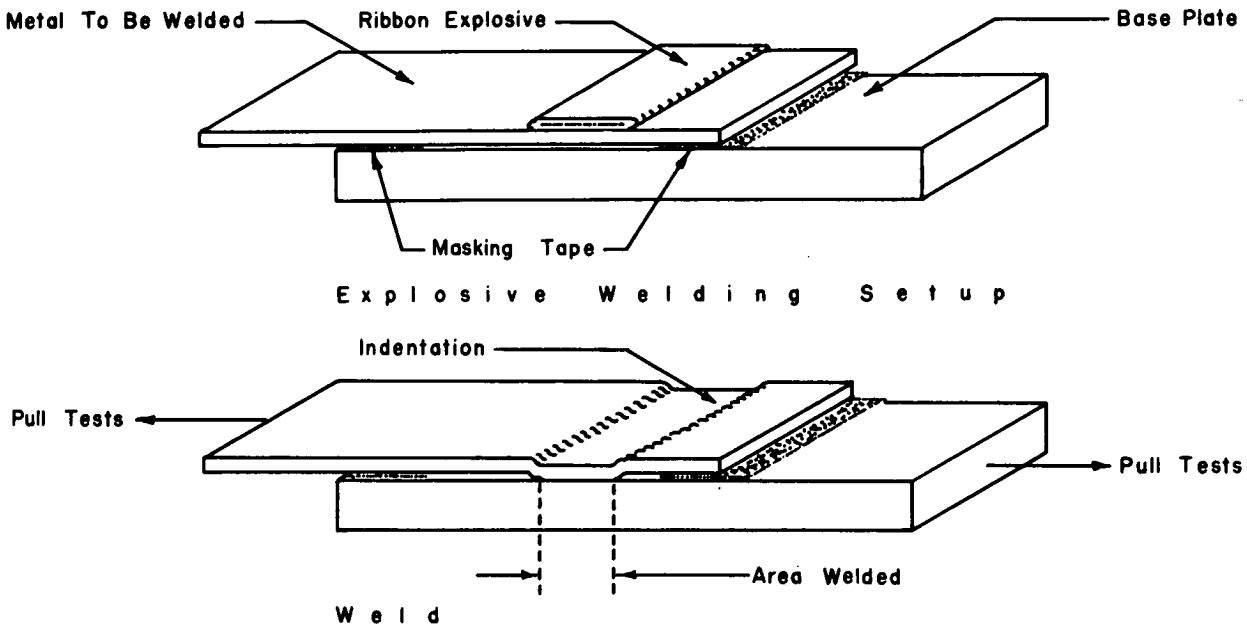
NASA TECH BRIEF

Langley Research Center

Small-Scale Explosive Welding of Aluminum



A new welding technique is being developed which uses very small quantities of a new explosive ribbon to accomplish small-scale lap-welding of aluminum plates. This simple technique can perform small controlled welding with no length limitations and requires minimal protective shielding.

The explosive, lead-sheathed RDX ribbon, has been specially designed to NASA specifications. The highest ribbon rating used in the present investigation is 5.32 g/m (25 grains/ft) which is 0.89-mm (0.035-in) thick. Sheet stocks of 2024-T3 Alclad, 2024-0, 6061-0, 7075-0, and 1100 in thicknesses from 0.84 to 3.18 mm (0.033 to 0.125 in) have been welded to 6.35 mm (0.250 in) plates of the same alloy and in other combinations thereof. Also, 6061-T6 has been welded to the above alloys and to 6061-T6, and 7075-T6 has been welded to 2024-T3 Alclad and to 6061-T6.

The surfaces to be welded are first prepared by chemical cleaning (except for commercially-pure aluminum, which is simply wiped with a solvent) and then positioned with a separation of 0.25 mm (0.010 in) by use of two parallel spacers 2.54 cm (1 in) apart. Welding is accomplished by igniting an explosive ribbon lying on the metal directly above the 0.25-mm (0.010 in) channel.

The explosion generates a pressure of several billion N/m^2 (several million psi) with which it drives a zone of the metal into the plate and forms a molecular bond at the interface, as shown in the figure. Welding under these conditions is essentially a high-velocity "cold-working" process which does not affect the temper of the metal.

Shear pull tests have been performed on welds of all combinations of the alloys mentioned which used RDX

(continued overleaf)

ribbon ratings of 1.5, 2.1, 3.2, 4.3, and 5.3 gm/m (7, 10, 15, 20 and 25 grains/ft). Results show that weld set-ups (explosive quantity/metal thickness) can be optimized to provide weld strength up to 90 percent of the tensile strength of the parent metal. This lower weld strength is caused by the pressure-induced indentation which decreases the cross-sectional area of the metal.

This technique has a further capability in the welding of plates of equal thicknesses. In this case, the plate is first separated by as little as 0.25 mm (0.010 in). A ribbon explosive is then placed on each side of the stacked plate directly opposite each other and the explosion is initiated. The plates are driven together, and, on impact, a weld is produced in the same manner described earlier. Since the two explosive ribbons are directly opposing, no unbalancing forces are created and, consequently, no displacement occurs.

In addition to explosive welding under normal atmospheric conditions, satisfactory results were also obtained under a vacuum of 2×10^{-5} Torr.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
Langley Research Center
Langley Station Mail Stop 139A
Hampton, Virginia 23365
Reference: TSP72-10002

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to Patent Counsel, NASA Langley Research Center, Hampton, Virginia 23365.

Source: L. J. Bement
Langley Research Center
(LAR-10941)